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RECORDS OF MEETINGS.

One thousand and seventy-fourth Meeting.

October 29, 1918.— Special Meeting.

A special meeting was held at the House of the Academy at 8.30 p.m. for the purpose of giving a reception to the British Educational Mission to the United States, composed of the following persons:— Dr. Arthur Everett Shipley, Sir Henry Miers, the Rev. Edward Mewburn Walker, Sir Henry Jones, Dr. John Joly, Miss Caroline Spurgeon and Miss Rose Sidgwick.

Invitations to the reception were sent to the Presidents and Deans of all the New England Colleges and to Mr. and Mrs. Charles Storrow, Mr and Mrs. W. F. Bentinck-Smith, Mr. and Mrs. S. C. Murfitt, the Earl of Camperdown, Mr. and Mrs. Charles Stewart, and Mr. and Mrs. McKibbin. One member of the family of each Fellow of the Academy was also invited. There were about two hundred persons present.

One thousand and seventy-fifth Meeting.

November 13, 1918.— Stated Meeting.

The Academy met at its House.

The President in the Chair.

There were thirty Fellows and one guest present.

The following letters were presented by the Corresponding Secretary:— from Brooks Adams, Edward Capps, C. A. Coolidge, E. B. Delabarre, W. H. P. Faunce, E. W. Forbes, Morris Gray, I. M. Hays, G. L. Hendrickson, E. C. Hills, A. M. Huntington, T. N. Page, Leighton Parks, Endicott Peabody, F. G. Peabody, H. B. Phillips, Rudolph Schevill, D. L. Webster, accepting Fellowship; from Gamaliel Bradford, declining Fellowship. The Corresponding Secretary read a letter from Professor F. H. Newell on behalf of the Committee on Reconstruction Problems of the National Research Council suggesting the coöperation of scientific societies in the study of post-bellum problems. This letter was referred to the Council.

The Chair announced the following deaths:— Grove Karl Gilbert, Class II., Section 1; Frederick Remsen Hutton, Class I., Section 4; Charles Card Smith, Class III., Section 3; George Mary Searle, Class I., Section 1; Arlo Bates, Class III., Section 4; William Leslie Hooper, Class I., Section 2; James Jackson Putnam, Class II., Section 3; Samuel Wendell Williston, Class II., Section 1; and Sir James Augustus Henry Murray, Foreign Honorary Member in Class III., Section 4.

Biographical notices were presented as follows: Francis Humphreys Storer by Charles W. Eliot, Francis Blake by Charles R. Cross, and William Bullock Clark by B. K. Emerson.

The Rumford Medals were presented to Professor Percy Williams Bridgman, of Cambridge, Mass., for his Thermodynamical Researches at Extremely High Pressures.

Professor Cross, Chairman of the Rumford Committee, stated the grounds on which the award was made, as follows:—

"The researches of Professor Bridgman for which the Academy has awarded to him the Rumford Premium comprehend an extended and remarkable investigation of the thermodynamical properties of water and to a certain extent, of other liquids, under unprecedentedly great pressures. This involved a study of the relation between temperatures, volumes, and pressures, the latter through an extremely great range.

The position of these studies in the history of scientific research will be best appreciated through a brief reference to historical data. In 1661 Boyle discovered the "Law" now bearing his name that the volume of a gas through a great range varies inversely as the pressure upon it. Mariotte in France in 1676 independently made and published the same discovery. Charles and, shortly afterward, Gay Lussac in 1802 discovered the facts regarding the expansion of ordinary gases with rise of temperature, *viz*: that for different gases for each degree through a large range this is the same definite fraction of the original volume. This fact became known as the "Law of Charles" or of Gay Lussac. Further study of the subject was made by Dulong and Arago, in 1829, with the design of ascertaining the limits within which the so-called laws were exact and later, by a great experimenter, Regnault, in 1847, through whose ingenious processes highly important deviations from the laws at high pressures (up to 27 atmospheres) were found. Studies were made by him on the pressure of steam as related to temperature and also measurements of the expansion of mercury and some other liquids. Amagat in his researches in 1869 and the following years reached pressures up to 3,000 atmospheres. The liquefaction and solidification of the so-called "permanent gases" by Cailletet and Pictet and the related studies by Andrews of the "critical point" were also most important.

Referring to liquids, the compressibility of water, that is, the relation of volume to pressure, was first measured by Jacob Perkins of Newburyport, a member of this Academy in 1820, and later Oersted and others investigated the subject further. Amagat, who worked also in this field, employed the highest pressures by far that had been reached even up to 3,000 atmospheres, as already remarked, and Tammann raised this to 3,500 atmospheres. But, even before reaching these extreme pressures the leakage of the packing and the joints of the piezometer became quite intolerable. Also James Thomson and his brother William had shown in 1850 the effect of pressure in lowering the melting point of water.

This rapid sketch will indicate sufficiently well for present purposes what was the condition of this branch of physics at the beginning of the work of Mr. Bridgman.

About ten years since Mr. Bridgman began an extended series of experiments upon the relations between the pressure, volume and temperature which obtain with different substances, particularly liquids and solids. Previous experimenters as just stated had found it impossible to maintain pressures greater than 3,000 atmospheres on account of the apparently insuperable difficulty from leakage at the joints of the movable parts of the compression apparatus. By a most ingenious device Mr. Bridgman succeeded in overcoming this defect so completely that he was able to subject the substance to be studied to pressures up to 20,000 atmospheres, or even higher, without serious difficulty. This accomplished, he was able to enter upon a series of researches upon the phase relations (volume-pressure-temperature) of water in its liquid and solid states as well as those of certain other liquids, with results which widely transcend in extent and value all that had been reached by earlier researchers. He designed a direct primary pressure gauge of very simple construction, and secondary gauges based upon the change of resistance of mercury or manganin calibrated by the former were also employed.

A brilliant series of experiments was made by which were studied the thermodynamic properties of liquid water up to 80 degrees temperature and 20,000 kg/cm^2 pressure, and also those of five forms of ice, that is, forms which have different and novel phase relations. Two of these were newly discovered by Mr. Bridgman.

Studies were made of various other liquids and the changes of phase under pressure of eleven chemically different substances were likewise ascertained.

The interesting and important fact is indicated by the curves of Professor Bridgman that for the passage from the solid to the liquid state there is no critical point, a complete difference from that which occurs on the passage from the liquid condition to that of vapor.

In later papers a study of polymorphic changes is described with important results, and an investigation of the electric properties of metals under pressure, which subject is still occupying Professor Bridgman's attention, except as it has been interrupted by duties incident to the Great War.

Moreover, Professor Bridgman has not confined himself to pure experimentation, but has considered analytically the thermodynamics of the subject which he has investigated.

The Rumford Committee considers itself fortunate to have been able by its grants to aid the researches of Professor Bridgman and so to fulfill the desire of the Supreme Court of the Commonwealth that appropriations made from the Rumford Fund for researches may lead to the award of the Rumford Premium.

The presentation of the medals was made by the President to Dr. Bridgman, who expressed his appreciation of the honor.

The following motion was made by Mr. Brooks Adams : — That the Chair appoint a Committee of five, with power to add to its number and to fill vacancies, to consider and report on the effect which the war has had upon the attitude of science.

First: Toward the use and preservation of food and the conservation thereof; and

Second: Toward the use and conservation of fuel, and the development of additional supplies thereof.

The motion was debated by Professors E. B. Wilson and W. T. Sedgwick and was not carried.

Vice-President Davis offered a resolution calling on various learned Societies to join with the Academy in urging the establishment of a League of Nations.

It was

Voted, That the above motion be laid on the table.

The resignation of the Recording Secretary was announced and referred to the Council.

The following Communication "Recent Advances in Stellar Photography" by Professor S. I. Bailey was announced for the meeting, but because of his sudden illness, only a portion of the communication was given.

The following papers were presented by title: — 1. On the Theory of Reed Instruments. 2. Note on the Ballistic Resistance Function. 3. On the Dynamics of the Rifle Shot from the Shoulder. By A. G. Webster.

One thousand and seventy-sixth Meeting.

December 11, 1918.— Stated Meeting.

The Academy met at its House.

The President in the Chair.

There were forty-seven Fellows present.

The Corresponding Secretary presented a letter of acceptance of Fellowship from Walter Hines Page.

The Chair announced the following deaths: Charles R. Van Hise, Class II., Section 1; Franklin Paine Mall, Class II., Section 3; Andrew D. White, Class III., Section 2, Fellows; and Adolf, Ritter von Baeyer, Class I., Section 3; Hermann, Graf zu Solms-Laubach, Class II., Section 2; Angelo Celli, Class II., Section 4; and Emil von Behring, Class II., Section 4, Foreign Honorary Members.

The President announced that to his gratification Dr. Bigelow had withdrawn his resignation as Recording Secretary.

It was Voted,

That the thanks of the American Academy of Arts and Sciences be given to Mr. Charles Stewart, Miss Freeman, and the J. L. Hammett Co. for their courtesy in loaning to the Academy the British and American flags at the recent reception offered to the British Educational Mission.

The following vote of the Council was reported : —

That the Librarian be requested to deposit the following volumes in the Library of the Massachusetts Historical Society, as a Special Deposit, subject to recall to the Library of the Academy by a vote of the Council:—

	Vols.
Connecticut. Acts and Laws. 1750–[52]. New London, 1750. F.	1
Connecticut. Acts and Laws. 1784. New London, 1784. F.	1
Great Britain. Abridgment of Public Statutes, by John Gay, L., 1739	2
Massachusetts. Acts and Laws. 1692–1764. Bost., 1759–64. F. [With Notes by Bowdoin].	1
Massachusetts. Acts and Laws. 1692–1755. Boston, 1742–55. F.	1
Massachusetts. Acts and Laws. 1780–85. Boston, 1781–[85]. F.	1
Massachusetts. Laws [1785–87]. Boston, 1786. Q.	1
Massachusetts. Journal of House, 1761–62, 1770–71, 1771–72, 1772–73, 1773–74	5
Massachusetts. Perpetual Laws. 1780–1800, 1801. O.	3
Massachusetts. Private and Special Statutes, 1780–1805, Boston, 1805	3
Massachusetts. Resolves, 1785–87, Boston, 1785–87	1
New York. Laws, 1691–1773, N. Y., 1774	1

NEWSPAPERS

Boston Chronicle, 1767–70	3
Boston Daily Advertiser, July, 1823–June, 1824	2
Boston Gazette, 1802	1
Boston News Letter, and Boston Post Boy, 1760–61	1
Boston Newspapers (miscellaneous) 1763–74, 76–84, 86 (Jan.–Aug.)	21
Boston Post Boy, 1759–60	1
Columbian Centinel, 1794–95, 1802	2
Federal Orrery, 1794–96	1
Massachusetts Centinel, 1786–88	2
Massachusetts Spy, 1784–85, 1788–1808, 1823–30	23
New England Palladium, 1802	1
New York Herald, 1795–96	1
	80

Vice-President Davis' motion in regard to a petition in favor of a League of Nations having been taken from the table, it was withdrawn by him with the understanding that it would be replaced by a petition to be signed by members of the Academy as individuals.

The following communication was given, Professor A. G. Webster, "A Student's Recollections of Berlin under Three Kaisers, with Glances at Paris."

The following paper by Thomas Willing Balch was presented by title: "The Origin of the Name Metz."

The meeting then adjourned to the Reception Room where an informal exhibition of much interest was held.

One thousand and seventy-seventh Meeting.

JANUARY 8, 1919.— STATED MEETING.

The Academy met at its House.

The PRESIDENT in the Chair.

There were thirty-three Fellows and one guest present.

A letter was presented from Professor W. R. Thayer, Corresponding Secretary of the Massachusetts Historical Society, acknowledging the deposit of volumes from the library of the Academy.

The Corresponding Secretary reported a vote of the Council that it is inexpedient to take further action at this time in regard to the nomination of Resident Associates.

The President commented briefly on the death of Ex-President Roosevelt and announced the following deaths:—Timothy Dwight, Class III., Section 2; Walter Hines Page, Class III., Section 4; John Duer Irving, Class II., Section 1., who was elected May 9, 1917, and died in France, July 20, 1918, never having accepted Fellowship.

The following Communications were presented:—

Dr. Thomas Willing Balch, "The Origin of the Name Metz."

Dr. Frederick C. Shattuck, "Epidemics of Influenza and Other Diseases."

Prof. Roland Thaxter, "On New Laboulbeniales from Chile and New Zealand."

The meeting then adjourned.

One thousand and seventy-eighth Meeting.

February 12, 1919.— Stated Meeting.

The Academy met at its House.

The President in the Chair.

There were forty-one Fellows and two guests present.

The President announced the following deaths:— Wallace Clement Sabine, Class I., Section 2; Clarence John Blake, Class I., Section 2; Edward Charles Pickering, Class I., Section 1.

The Librarian announced the gift of thirty-six volumes from the estate of Charles Card Smith, which have been added to the catalogue and placed on the shelves.

The following Communications were presented:—

Prof. E. K. Rand, "Supposed Autographa of Iohannes Scottus."

Prof. Barrett Wendell, "Dreams as a Factor in Literature."

Prof. B. L. Robinson, "Some Recent Investigations on South American Plants."

The following paper was presented by title:— Dr. A. E. Kennelly, "A New Geometrical Model for the Orthogonal Projection of the Cosines and Sines of Complex Angles."

The meeting then adjourned.

One thousand and seventy-ninth Meeting.

MARCH 12, 1919.— STATED MEETING.

The Academy met at its House.

The PRESIDENT in the Chair.

There were forty-three Fellows and two guests present.

The Council announced that it had adopted the recommendations in the following report on the more frequent use of the House of the Academy.

Joint report of a Special Committee composed of Professor Barrett Wendell, Professor G. F. Moore, Professor W. T. Sedgwick and the House Committee.

It is recommended that the following measures be adopted:—

There shall be a series of not more than four "Open Meetings" yearly. Notices to be sent to Fellows and invitations to a selected list of young men approximately eligible for membership, and such others as the Officers of the Academy may desire. Each Fellow and guest shall have the right to bring one lady. The meetings shall be held at, say, four P.M., and shall consist of a prepared address of not more than thirty or forty minutes on some topic of current literary, scientific or educational interest, to be presented by a member of the Academy or some distinguished visiting stranger; to be followed by light refreshments in the upper room, where anyone who could not come earlier will be welcome.

It is suggested that a committee of ladies, selected from the wives of members, be appointed to take charge of the refreshments and reception after the address.

No china, etc., shall be purchased until the success of these meetings is assured. Such articles are to be provided by a caterer for the first few meetings.

A special committee shall be appointed to select the speakers, who should be chosen to represent the different classes of the Academy.

The general arrangement for these meetings is to be left in the hands of the Committee on Meetings.

As soon as the House Committee can secure latch keys, a notice shall be sent to the Fellows that they can obtain keys by applying to the Assistant Librarian. A list shall be kept of all Fellows holding latch keys.

Members making use of the Academy Building shall be invited to bring their friends, and are expected to inscribe the names of their guests in a stranger's book to be provided for the purpose, and kept in the small committee room.

(signed) G. R. Agassiz,
For the Committees.

The Chair appointed the following Councillors to act as Nominating Committee, and announced that he should not be a candidate for re-election, expressing his thanks for the highest honor he had ever received:—

Harvey N. Davis, of Class I.
Benjamin L. Robinson, of Class II.
Fred N. Robinson, of Class III.

On recommendation of the Council, the following appropriations were made for the ensuing year:—

From the income of the General Fund, $8,600, to be used as follows:—

for General and Meeting expenses	$ 700.00
for Library expenses	3,300.00
for House expenses	2,000.00
for Treasurer's expenses	800.00
for printing biographical notices	300.00
for use of the Publication Committee	1,500.00

From the income of the Publication Fund, $3,360.08, to be used for publication.

From the income of the Rumford Fund, $3,188.20, to be used as follows:—

for Research	$1,000.00
for Books, periodicals and binding	300.00
for Publication	600.00
for use at the discretion of the Committee	1,288.20

From the income of the C. M. Warren Fund, $800, to be used at the discretion of the Committee.

The following preliminary notice was presented by Dr. Francis H. Williams.

During the war, Mr. Elof Benson invented a method for locating submarine objects, depending upon sound shadows. While I was trying to assist him to get recognition for his method, we both became interested in devices for receiving signals under water and in the air, one of which was a coil made of strips of soft iron covered with a vortex winding of insulated copper wire. When this was connected with an amplifier, we found that it responded not only to electric and magnetic waves, but also to the voice. We failed to understand, nor did any among the physicists to whom we demonstrated our work explain *why* the coil responded to the voice.

Finally, one of us attempted to find this explanation, and devised experiments to that end with a modified coil. As one result of these experiments, I desire to state my belief that sound waves can disturb a magnetic field and thus set up a current in a near-by coil.

I hope at some future time to have an opportunity to present to the Academy an account of these experiments.

The following Communications were presented:—

Professor Ephraim Emerton, "The First European Congress."

Professor Cornelius Van Vollenhoven, "Holland's International Policy."

The following paper was presented by title:

"A New Mixed Problem in Partial Differential Equations arising from the Theory of Wind Instruments." By Arthur G. Webster.

The meeting then adjourned.

One thousand and eightieth Meeting.

APRIL 9, 1919.— STATED MEETING.

The Academy met at its House.

The PRESIDENT in the Chair.

There were thirty-four Fellows and one guest present.

The Corresponding Secretary presented the following letters:— from George E. Hale, of the National Research Council, inviting the Academy to participate in the organization of a division of Foreign Relations, from the Secretary of the League for the Preservation of American Independence, asking the coöperation of the Academy; from the Harvard Biblical Club, thanking the Academy for the use of the Committee Room during the past year.

The Chair announced the death of John Wallace Baird, Fellow in Class II., Section 3.

Dr. Arthur A. Noyes was appointed to represent the Academy as a member in the Division of Foreign Relations of the National Research Council.

The President referred the proposed alteration of the Statutes to a Committee consisting of E. B. Wilson, H. W. Tyler and E. V. Huntington.

The following Communications were presented:—

Prof. E. S. Morse, "Observations on Living Lamellibranchs of New England."

Prof. A. E. Kennelly, "A New Geometrical Model for the Orthogonal Projection of the Cosines and Sines of Complex Angles."

Dr. G. M. Allen, "Some Habits of Cave-frequenting Bats."

The meeting then adjourned.

One thousand and eighty-first Meeting.

MAY 7, 1919.— SPECIAL MEETING.

The Academy met at its House.

The PRESIDENT in the Chair.

There were thirty-four Fellows and two guests present.

Professor Charles R. Cross, Chairman, on behalf of the Rumford

Committee, stated the grounds for the award of the Rumford Premium to Professor Theodore Lyman, of Cambridge, as follows:—

The Rumford Premium has been awarded by the Academy to Professor Lyman "for his researches on light of very short wave length."

If we view the spectrum with the red at our left and the violet at our right, the lengths of the ether waves corresponding to the different colors in the order given by Newton, red, orange, yellow, green, blue, indigo, violet, run from longer to shorter as is the case with the sound waves of the piano from the bass strings at the left to the acute strings at the right. The unit in which to measure these wave lengths most conveniently is the tenth-meter or Ångstrom unit (Å) which is 10^{-10} meters. In terms of this unit the wave length of the extreme red rays at the black Fraunhofer line A of the spectrum is 7,600. That of the violet rays at the extreme right of the spectrum at the black Fraunhofer line H is 3,969. For over one hundred and twenty-five years after Newton's first writing these were tacitly assumed to be the extreme limits of radiation. In 1800, Sir William Herschel discovered that there were radiations affecting the thermometer outside of the visible spectrum beyond the red, a fact which, however, was received with much skepticism for some time, and his son, Sir John Herschel, forty years later discovered the existence of "cold" Fraunhofer lines in the infra-red, as this region has come to be called. In 1880, Captain Abney by photographic methods of his own devising succeeded in detecting and measuring infra-red rays in the solar spectrum as far down as 10,000 Å. For this discovery, together with certain allied work he was awarded the Rumford Medal of the Royal Society of London. Shortly after this (1881) Professor Langley of the Allegheny Observatory, using a newly devised thermometric instrument invented by him, the bolometer, based on the change in electrical resistance sustained by a platinum strip under changing temperature, demonstrated the existence of an infra-red spectrum (solar) down to 20,000 and later to 55,000 Å the Fraunhofer lines in which he mapped to that limit, while detecting the presence of sensible radiation down to 180,000 Å. Because of this research he was awarded the Rumford Medal of the Royal Society and, in the same year, the Rumford Medal of the American Academy. This is the only case in which both of these awards have been made to the same person. The existence of far longer infra-red ether waves has been proved by Rubens and his students in Berlin, among whom were several Americans, two of these being E. F. Nichols and R. W. Wood, both of whom have received the Rumford Medal of this Academy. An indirect method, that of measuring the "rest-strahlen" was chiefly employed. These go down to one-third mm. These longest "heat waves" almost reach the length of the shortest Hertz waves, which are only about 2 mm. long and whose length increases up to thousands of feet as with those used in radio-telegraphy.

At about the same time that the elder Herschel discovered the existence of infra-red rays, Ritter and Wollaston showed that certain silver salts were acted upon photographically by previously unknown radiations outside of the violet, the ultra-violet rays, and E. Becquerel demonstrated their photographic action in 1842 as existing up to 3,400 Å. in the solar spectrum. Stokes's discovery of fluorescence in 1851 enabled him by this new method to detect ultra-violet radiations of wave-length 3,000 Å in sunlight, and up to 1850 Å in the light of the electric spark between metal electrodes. In the study of these very highly refrangible rays Stokes was obliged to use prisms and lenses of quartz on account of the great absorptive power of glass for such radiations. Cornu reached the same limit by photography.

A most serious obstacle to the further prosecution of researches of this character was the highly absorptive power of atmospheric air for these extreme rays even in thin layers. This set a limit to further advances by known methods.

Victor Schumann, somewhat before 1890, undertook to overcome the difficulty by constructing a vacuum spectroscope and camera. In this, the rays from an electric discharge *e. g.*, through hydrogen in a vacuum tube with a fluorite window, passed through an inclosed optical train of prism and lenses of fluorite, which substance he had found to be more transparent to higher radiations than quartz. The rays passed through a rarefied atmosphere of hydrogen on their way to the photographic plate instead of through air at the ordinary density. Under these conditions it was found that radiations far above any previously detected were recognized on the photographic plate. Schumann also employed an emulsion of his own invention in order to secure better action with such short waves as those he was to deal with, which were strongly absorbed by gelatine. As a result he obtained excellent photographs of hydrogen lines which he believed to have a wave length as short as 1,000 Å. He also mapped the lines of various other gases. But manifestly using as he did a prismatic spectrum it could not be certain first that higher radiations were not absorbed by the fluorite and second that the wave-lengths of those which were transmitted by it were correctly estimated. In fact there were serious errors arising from both these causes.

It was here that Mr. Lyman took up the matter. He avoided Schumann's difficulty arising from the use of a prism spectroscope by employing a Rowland concave diffraction grating, which serves at once as a mirror wherewith to focus the rays upon the sensitive plate and a grating to disperse them and which, moreover, allows exact measurement of the wave-length of the photographed lines, while, of course, no prisms or lenses being used the difficulty arising from their absorption does not exist. The grating had 15,028 lines to the inch. He found that a grating was physically suitable for use with these high radiations, and he devised an ingenious two-slit method for determining accurately the wave lengths of all such lines as should be photographed. He also made use of a curved photographic plate for better definition.

As was the case in Schumann's research the whole apparatus was placed in a vacuum chamber. This was filled with hydrogen gas scrupulously purified and rarefied to a density of about 1/500 of an atmosphere.

To avoid difficulty from the absorption of the radiations from the electric spark which would be exercised even by a fluorite window in the vacuum tube in which the electrical spark was produced this opened directly into the chamber containing the spectroscope so that the radiations passed only through rarefied hydrogen before and after they fell upon the grating and reached the camera. By this device Professor Lyman was able to photograph and measure rays whose wave length was only 905 Å, and later those of wave length 600 Å. He showed that most serious absorption occurred with Schumann's optical train, so that no rays shorter than 1,267 Å were transmitted, which was therefore Schumann's limit. He mapped with great care the rays from the spark in a hydrogen vacuum tube, recording many hundred lines. He also studied the radiations in the Schumann region produced by the electric spark taken between electrodes of other substances, such as aluminium and the alkaline earths, and likewise the absorption of certain solids used for optical purposes and of various gases. It was with one of the latter, helium, that the extreme short wave length, 600 Å, was reached. In the progress of the investigations various new lines were measured which were of importance as verifying theoretical prediction regarding spectral series. Of course, in all these last researches the spark had to be taken within a vacuum tube with a fluorite window, so that no radiations above Schumann's limit or thereabouts could be reached.

There is a great region beyond these ultra-violet radiations studied by Schumann and Lyman, doubtless occupied by rays which have not yet been detected although searched for, but far above this limit are found the X-rays, long believed to be ether waves, and more recently proved to be such by the actual measure of their length by the Braggs, father and son. Their wave length is 1 Å, more or less, according to conditions. This is the extreme limit of measured ether waves, but the so-called "Gamma rays," emitted by radioactive substances, have a wave length estimated at perhaps 1/10 Å.

The President presented the medals to Professor Lyman, who expressed his thanks, and then addressed the Academy on "Flash and Sound Ranging with the American Forces in France."

The meeting then adjourned.

One thousand and eighty-second Meeting.

May 14, 1919.— Annual Meeting.

The Academy met at its House.

The President in the Chair.

There were thirty-six Fellows and one guest present.

The Chair announced the death of Joseph Barrell, Fellow in Class II., Section 1.

The following report of the Council was presented:—

Since the last report of the Council, there have been reported the deaths of eighteen Fellows: G. K. Gilbert, F. R. Hutton, C. C. Smith, G. M. Searle, Arlo Bates, W. L. Hooper, J. J. Putnam, S. W. Williston, C. R. Van Hise, F. P. Mall, A. D. White, Timothy Dwight, W. H. Page, W. C. Sabine, C. J. Blake, E. C. Pickering, J. W. Baird, Joseph Barrell; and of five Foreign Honorary Members: J. A. H. Murray, Adolf von Baeyer, Hermann zu Solms-Laubach, Angelo Celli, Emil von Behring.

Twenty Fellows were elected by the Academy in May, 1918, of which number, one has declined Fellowship. One Fellow has resigned. Under the new provisions of the Statutes, the Council elected in April, 1919, twenty-five Fellows and nine Foreign Honorary Members.

The roll now includes 540 Fellows and 71 Foreign Honorary Members.

The annual report of the Treasurer was read, of which the following is an abstract:—

General Fund.

Receipts.

Balance, April 1, 1918	$5,735.36	
Investments	5,875.72	
Assessments	2,945.00	
Admissions	100.00	
Sundries	180.55	$14,836.63

Expenditures.

Expense of Library	$2,848.55
Expense of House	1,895.95
Treasurer	445.48
Assistant Treasurer	250.00
General Expense of Society	666.44
President's Expenses	51.25

Interest on Bonds, bought	.80	
Income transferred to principal	317.82	$6,476.29
Balance, April 1, 1919		8,360.34
		$14,836.63

RUMFORD FUND.

Receipts.

Balance, April 1, 1918	$2,902.21	
Investments	3,655.46	
Sale of publications	22.73	
Grant returned	81.33	$6,661.73

Expenditures.

Research	$1,300.00	
Periodicals and binding	101.54	
Medals	1,031.17	
Sundries	4.25	
Interest on Mortgage, bought	5.50	
Income transferred to principal	155.04	$2,597.50
Balance, April 1, 1919		4,064.23
		$6,661.73

C. M. WARREN FUND.

Receipts.

Balance, April 1, 1918	$3,673.58	
Investments	1,158.14	$4,831.72

Expenditures.

Sundries	$3.00	
Income transferred to principal	52.59	$55.59
Balance, April 1, 1919		4,776.13
		$4,831.72

PUBLICATION FUND.

Receipts.

Balance, April 7, 1919	$2,815.49	
Appleton Fund investments	1,049.63	
Centennial Fund investments	2,584.21	
Author's Reprints	631.98	
Sale of Publications	270.44	$7,351.75

Expenditures.

Publications	$5,716.53	
Sundries	10.00	
Income transferred to principal	163.72	$5,890.25
Balance, April 1, 1919		1,461.50
		$7,351.75

FRANCIS AMORY FUND.

Receipts.

Investments	$1,222.50	$1,222.50

Expenditures.

Publishing statement	$63.40	
Interest on Bonds, bought	7.50	
Charge to cancel Premium on Bonds	45.00	
Income transferred to principal	1,106.60	$1,222.50

The following reports were also presented:—

REPORT OF THE LIBRARY COMMITTEE.

The Librarian begs to report for the year 1918–1919, as follows: —

During the year 93 books have been borrowed by 16 persons, including 12 Fellows and 2 libraries. A great many books have been consulted, though not taken from the library. All books taken out have been returned or satisfactorily accounted for.

The number of volumes on the shelves at the time of the last report was 35,700. 537 volumes have been added, making the number now on the shelves 36,237. This includes 19 purchased from the income of the General Fund, 10 from that of the Rumford Fund, and 508 received by gift or exchange. The pamphlets added during the year number 123.

The expenses charged to the Library during the financial year are:—

Salaries	$2,300.00
Binding:—	
General Fund	252.55
Rumford Fund	29.05
Purchase of periodicals and books:—	
General Fund	171.15
Rumford Fund	78.09
Miscellaneous	119.25
Total	$2,950.09

A. G. WEBSTER, *Librarian.*

May 14, 1919

REPORT OF THE RUMFORD COMMITTEE.

The Rumford Committee respectfully reports as follows:—

The Committee met on November 13, 1918, and elected Charles R. Cross, Chairman, and Arthur G. Webster, Secretary.

During the past year grants in aid of research have been made as ollows:—

November 13, 1918. To Professor R. C. Gibbs for the continuance of his investigation on the absorption of organic and silver solutions for ultra-violet and infra-red rays (additional) $250

To Dr. Louis T. E. Thompson in aid of his research on the development of a gun sight with two magnifications, for application to anti-aircraft guns $250

January 9, 1919. To Professor H. M. Randall, in aid of his research on the infra-red spectrum (additional) $200

To Professor Alpheus W. Smith in aid of his investigations on

the Hall effect and allied phenomena in rare metals and their alloys (additional)	$100
To Professor Julius Stieglitz in aid of the publication of Marie's tables of constants (additional)	$250
To Professor A. G. Webster in aid of his researches on phrodynamics and practical interior ballistics	$500
May 14, 1919. To Professor P. W. Bridgman in aid of his research on the effect of temperature and pressure on the physical properties of materials, particularly their thermal conductivity (additional)	$400
To Professor Horace L. Howes in aid of his research on the experimental study of the effect of temperature on the luminescence and selective radiation of the rare earths	$500

May 14, 1919, it was voted: To publish, as a Memoir of the Academy by an appropriation from the income of the Rumford Fund not exceeding $1,000, the results of measurements of the light of faint stars made at several Observatories possessing large telescopes by the use of the form of photometer devised for that purpose by Professor E. C. Pickering and constructed by means of a grant from the Rumford Committee.

Reports of progress in their respective researches have been received from the following persons:— C. G. Abbot, W. M. Baldwin, R. T. Birge, P. W. Bridgman, W. W. Campbell, A. L. Clark, H. Crew, F. Daniels, A. L. Foley, E. B. Frost, R. C. Gibbs, H. C. Hayes, H. P. Hollnagel, L. R. Ingersoll, N. A. Kent, F. E. Kester, L. V. King, C. A. Kraus, E. Kremers, C. E. Mendenhall, R. A. Millikan, R. S. Minor, E. L. Nichols (finished), C. L. Norton, F. Palmer, Jr., J. A. Parkhurst, H. M. Randall, T. W. Richards, F. K. Richtmyer, G. W. Ritchey, M. A. Rosanoff (finished), J. Stieglitz, A. St. John (research discontinued), F. A. Saunders, W. O. Sawtelle, A. W. Smith, B. J. Spence, L. T. E. Thompson, O. Tugman, F. W. Very, A. G. Webster, D. L. Webster, R. W. Wood.

No papers have been published by the Academy at the expense of the Rumford Fund during the present year.

The various reports from grantees received last year and the present year indicate that the exigencies of the war have made such demands on the time and abilities of scientific men of the country as practically to preclude their continuance of investigations to any considerable extent. The reports, however, indicate an intention and expectation of an early resumption of individual research.

The Committee desires to call attention to a marked improvement in the execution of the engraved portion of the recently-presented Rumford medals, which has been secured through the interest and energy of the Treasurer of the Academy. For a long time past this lettering has uniformly been done in plain square Roman type, which has abolished such occasional manifestations of the idiosyncrasies of individual engravers as had occurred previously. Though the work was entrusted to the best local skill available, nevertheless, the results were not always beyond criticism. The plain lettering used is probably harder to execute than script or ornamentation, and the difficulty is frequently enhanced by the length of the inscription necessary and often by the length of the individual words composing it as well. Realizing these facts, the Treasurer took up the matter with the authorities of the United States Mint at Philadelphia and secured the active interest of the chief engraver, who has taken charge of the engraving of the last two medals, employing the skill and improved methods thus available. As a result these are of a beauty far transcending that of any earlier ones. A marked improvement in the bronze replicas has also been made by a change in the character of the metal employed. The labors of Mr. Edes in this direction are warmly appreciated by the Committee.

It is impossible to close this report without a reference to the great loss recently sustained by the Committee directly, and indirectly by all those who may hereafter desire aid from the Rumford Fund, through the death of Professor Edward C. Pickering. The period through which his membership has extended is entirely unprecedented. From May, 1869, up to February last, his term of service was continuous except for a brief gap, 1890–1892, during which time he was awarded the Rumford Premium. Very rarely did he miss a meeting and never did he fail to give full attention to any matter which was before the Committee. His temperate judgment, totally unaffected by any other than scientific considerations, and his clearness of apprehension of the probable value of a proposed investigation, were of high importance. He was especially appreciative of the needs of younger men who were desirous of aid from the Fund, and fully recognized the hindrances to research which so often lie in their way in collegiate institutions. Particularly were all these characteristics to be depended upon when the award of the Rumford Premium was under consideration, in which case their value was inestimable. His judgment was exacting as to the merit of the candidate, but always kindly and considerate, his sole desire being to recognize important scientific results and through such recognition to stimulate the further labors of the recipient and of others working in similar fields.

His refinement of manner and thought and his cordial appreciation of all with whom he was associated made the sessions of the Committee delightful in their social aspect and will long be a cherished remembrance with his colleagues.

CHARLES R. CROSS, *Chairman.*

May 14, 1919.

REPORT OF THE C. M. WARREN COMMITTEE.

The C. M. Warren Committee begs to submit the following report:—

At the date of the last report to the Academy, the Committee had at its disposal $2,771.50. In March, 1919, the Academy made a further appropriation of $800.

One grant has been made during the year, namely, that to Professor Robert E. Wilson of $750 for the study of the hydrolysis of certain organic compounds, with particular reference to an exact study of phenomena which may be expected to throw desirable light upon the nature of the interface between two liquids. This investigation is a continuation of work done during the war in perfecting methods for the destruction of the so-called "mustard gas." This material, chemically known as di-chlorethylene sulphide, exhibited some highly interesting phenomena which, under the stress of war conditions, could not be followed up. The research promises to yield results of permanent interest.

The unexpended balance now in the hands of the Committee is $2,821.50.

No reports of publication of work carried on with the aid of grants from the C. M. Warren Fund have been received during the year, doubtless because so many of the investigators holding these grants have been engaged in war work.

Respectfully submitted,

H. P. Talbot, *Chairman*.

May 14, 1919.

Report of the Publication Committee.

The Committee of Publication submits the following report for the period from April 1, 1918, to April 1, 1919:—

During this period 846 pages of the Proceedings have been issued namely, Nos. 6–10, of Vol. 53, and Nos. 1–4 of Vol. 54; also 112 pages of the Memoirs, namely, No. 2 of Vol. 14.

Toward the expense of one of these numbers (Proceedings 53:7) Mr. Andrew McF. Davis contributed the sum of $100, and toward the expense of another (Proceedings 54:1) the Shaler Memorial Fund of Harvard University contributed $387.29. Both of these sums are included in the item of "extra" reprints.

The accounts of the Committee of Publication stand as follows:

Balance on hand April 1, 1918	$2,485.88
Appropriation for 1918–19	3,500.00
Proceeds from the sale of publications	270.44
Total available funds	6,256.32
Expenses	5,084.55
Balance on hand April 1, 1919	1,171.77

During the year authors have ordered through the Committee "extra" reprints to the amount of $631.98; to this sum should be added $1,146.00 for "extra" reprints of the article in the Memoirs, the bill for which was, by error, sent directly by the printer to the authors.

Professor Huntington, the Chairman of the Committee, has been at Washington since June, serving as Major in the United States Army, assigned to duty in the statistics branch of the General Staff.

Respectfully submitted,

Albert A. Howard, *Acting Chairman*.

May 14, 1919.

REPORT OF THE HOUSE COMMITTEE.

The House Committee submits the following report for 1918–19:—

With the balance of $20.30 left from last year, an appropriation of $2,000 and money received from other societies for the use of the rooms, the Committee has had at its disposal the sum of $2,040.30. The total expenditure has been $1,915.95, leaving an unexpended balance on April 1, 1919, of $124.35. The expenditure has been as follows:—

Janitor		$851.42
Electricity	A. Light	117.43
	B. Power	48.47
Gas		11.63
Water		8.00
Telephone		51.79
Coal	Furnace	593.66
	Water heater	44.10
Wood		23.30
Ash tickets		9.90
Care of elevator		34.41
Ice		18.00
Janitor's materials		28.88
Furnishings		29.45
Upkeep		43.01
Sundries		2.50
Total expenditure		$1,915.95

The amount of $20 contributed by other societies for the use of the building leaves the net expense of the House $1,895.95.

Meetings have been held as follows:—

The Academy	8
Harvard Biblical Club	7
The Colonial Society	4
American Antiquarian Society	1
Archæological Institute of America	1

The rooms on the first floor have been used many times for Committee meetings.

The Committee expended about $150 more than last year, which is accounted for in the advancing cost of everything. Had not the increased price of coal been in a great measure offset by the mildness of the winter, the difference in the coal bill ($637.76 for 1918–19, $602.30 for 1917–18) would have been considerably greater.

Not wishing to discharge the wife of the late janitor, the Committee has adopted the policy of retaining Mrs. Reardon and giving her the use of the janitor's rooms. A man to look after the furnace, etc., is hired only for the months during which the furnace is burning.

Respectfully submitted,

G. R. Agassiz, *Chairman.*

May 14, 1919.

It was

Voted, To amend the Statutes in accordance with the report of the Committee, as follows:—

Chapter IX., Article 1, paragraph 2, to read

"It shall consider all nominations duly sent to it by any Class Committee and act upon them in accordance with the provisions of Chapter III."

On motion of the Treasurer, it was

Voted, That the Annual Assessment be $10.00.

A biographical notice of S. W. Williston by H. W. Shimer was presented.

The question of printing communications from non-members was referred to the Publication Committee.

The annual election resulted in the choice of the following officers and committees:—

Theodore W. Richards, *President.*
Elihu Thomson, *Vice-President for Class I.*
Harvey Cushing, *Vice-President for Class II.*
George F. Moore, *Vice-President for Class III.*
Harry W. Tyler, *Corresponding Secretary.*
James H. Ropes, *Recording Secretary.*
Henry H. Edes, *Treasurer.*
Arthur G. Webster, *Librarian.*

Councillors for Four Years.

Cecil H. Peabody, *of Class I.*
Edward M. East, *of Class II.*
Charles B. Gulick, *of Class III.*

Finance Committee.

Henry P. Walcott,
John Trowbridge,
Harold Murdock.

Rumford Committee.

Charles R. Cross,
Arthur G. Webster,
Arthur A. Noyes,
Elihu Thomson,
Theodore Lyman,
Louis Bell,
Percy W. Bridgman.

C. M. Warren Committee.

Henry P. Talbot,
Charles L. Jackson,
Gregory P. Baxter,
Arthur A. Noyes,
Walter L. Jennings,
William H. Walker,
Arthur D. Little.

Publication Committee.

Edward V. Huntington, *of Class I.*
Jay B. Woodworth, *of Class II.*
Albert A. Howard, *of Class III.*

Library Committee.

Harry M. Goodwin, *of Class I.*
Thomas Barbour, *of Class II.*
William C. Lane, *of Class III.*

House Committee.

Louis Derr,
George R. Agassiz,
Wm. Sturgis Bigelow.

Committee on Meetings.

THE PRESIDENT,
THE RECORDING SECRETARY,
WILLIAM M. DAVIS,
EDWIN B. WILSON,
GEORGE F. MOORE.

Auditing Committee.

GEORGE R. AGASSIZ,
JOHN E. THAYER.

The Council reported that the following gentlemen were elected members of the Academy:—

Joseph Lipka, of Cambridge, as Fellow in Class I., Section 1. (Mathematics and Astronomy.)

George Abram Miller, of Urbana, as Fellow in Class I., Section 1. (Mathematics and Astronomy.)

Forest Ray Moulton, of Chicago, as Fellow in Class I., Section 1. (Mathematics and Astronomy.)

Virgil Snyder, of Ithaca, as Fellow in Class I., Section 1. (Mathematics and Astronomy.)

William Suddards Franklin, of Cambridge, as Fellow in Class I., Section 2. (Physics.)

Arthur Alphonzo Blanchard, of Cambridge, as Fellow in Class I., Section 3. (Chemistry.)

Frederick George Keyes, of Cambridge, as Fellow in Class I., Section 3. (Chemistry.)

Edward Mueller, of Cambridge, as Fellow in Class I., Section 3. (Chemistry.)

Ellwood Barker Spear, of Cambridge, as Fellow in Class I., Section 3. (Chemistry.)

Robert Seaton Williams, of Cambridge, as Fellow in Class I., Section 3. (Chemistry.)

Alpheus Grant Woodman, of Watertown, as Fellow in Class I., Section 3. (Chemistry.)

Henri Louis Le Chatelier, of Paris, as Foreign Honorary Member in Class I., Section 3. (Chemistry.)

William Henry Perkin, of Oxford, as Foreign Honorary Member in Class I., Section 3. (Chemistry.)

Frederic Harold Fay, of Boston, as Fellow in Class I., Section 4. (Technology and Engineering.)

Ferdinand Foch, of Paris, as Foreign Honorary Member in Class I., Section 4. (Technology and Engineering.)

Joseph Jacques Césaire Joffre, of Paris, as Foreign Honorary Member in Class I., Section 4. (Technology and Engineering.)

Waldemar Theodore Schaller, of Washington, as Fellow in Class II., Section 1. (Geology, Mineralogy and Physics of the Globe.)

Charles Barrois, of Lille, as Foreign Honorary Member in Class II., Section 1. (Geology, Mineralogy and Physics of the Globe.)

Raymond Pearl, of Washington, as Fellow in Class II., Section III. (Zoölogy and Physiology.)

George H. F. Nuttall, of Cambridge, as Foreign Honorary Member in Class II., Section 3. (Zoölogy and Physiology.)

Alexis Carrel, of New York, as Fellow in Class II., Section 4. (Medicine and Surgery.)

Charles Henry Brent, of Manila, as Fellow in Class III., Section 1. (Theology, Philosophy and Jurisprudence.)

Howard Nicholson Brown, of Boston, as Fellow in Class III., Section 1. (Theology, Philosophy and Jurisprudence.)

John Bassett Moore, of New York, as Fellow in Class III., Section 1. (Theology, Philosophy and Jurisprudence.)

Winslow Warren, of Dedham, as Fellow in Class III., Section 1. (Theology, Philosophy and Jurisprudence.)

Raymond Poincaré, of Paris, as Foreign Honorary Member in Class III., Section 1. (Theology, Philosophy and Jurisprudence.)

Pliny Earle Goddard, of New York, as Fellow in Class III., Section 2. (Philology and Archæology.)

Roy Kenneth Hack, of Cambridge, as Fellow in Class III., Section 2. (Philology and Archæology.)

William Henry Holmes, of Washington, as Fellow in Class III., Section 2. (Philology and Archæology.)

Arthur Anthony Macdonell, of Oxford, as Foreign Honorary Member in Class III., Section 2. (Philology and Archæology.)

Charles Downer Hazen, of New York, as Fellow in Class III., Section 3. (Political Economy and History.)

Charles Lemuel Nichols, of Worcester, as Fellow in Class III., Section 3. (Political Economy and History.)

George Walter Prothero, of London, as Foreign Honorary Member in Class III., Section 3. (Political Economy and History.)

Henry Dwight Sedgwick, of New York, as Fellow in Class III., Section 4. (Literature and the Fine Arts.)

The following Communication was presented: —

Professor A. M. Tozzer, "The Sacred Cenote of Chichen Itza, Yucatan, and its contents."

The following papers were presented by title:

"A Revision of the North American Species of Rana," by George Albert Boulenger (of England), presented by Samuel Henshaw and Thomas Barbour.

"A Step Forward in the Methodology of Natural Science (an introduction to the functional relation of one variable to each of a number of correlated variables, determined by a method of successive approximation to group averages, by George F. McEwen and Ellis L. Michael)," by Wm. E. Ritter.